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**International Perspectives of the Impact of Export Control and
Technology Transfer Regimes: The F/A-18 Case Study**

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Prepared for the Naval Postgraduate School, Monterey, California 93943

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Preface & Acknowledgements

During his internship with the Graduate School of Business & Public Policy in June 2010, U.S. Air Force Academy Cadet Chase Lane surveyed the activities of the Naval Postgraduate School's Acquisition Research Program in its first seven years. The sheer volume of research products—almost 600 published papers (e.g., technical reports, journal articles, theses)—indicates the extent to which the depth and breadth of acquisition research has increased during these years. Over 300 authors contributed to these works, which means that the pool of those who have had significant intellectual engagement with acquisition issues has increased substantially. The broad range of research topics includes acquisition reform, defense industry, fielding, contracting, interoperability, organizational behavior, risk management, cost estimating, and many others. Approaches range from conceptual and exploratory studies to develop propositions about various aspects of acquisition, to applied and statistical analyses to test specific hypotheses. Methodologies include case studies, modeling, surveys, and experiments. On the whole, such findings make us both grateful for the ARP's progress to date, and hopeful that this progress in research will lead to substantive improvements in the DoD's acquisition outcomes.

As pragmatists, we of course recognize that such change can only occur to the extent that the potential knowledge wrapped up in these products is put to use and tested to determine its value. We take seriously the pernicious effects of the so-called “theory–practice” gap, which would separate the acquisition scholar from the acquisition practitioner, and relegate the scholar's work to mere academic “shelfware.” Some design features of our program that we believe help avoid these effects include the following: connecting researchers with practitioners on specific projects; requiring researchers to brief sponsors on project findings as a condition of funding award; “pushing” potentially high-impact research reports (e.g., via overnight shipping) to selected practitioners and policy-makers; and most notably, sponsoring this symposium, which we craft intentionally as an opportunity for fruitful, lasting connections between scholars and practitioners.

A former Defense Acquisition Executive, responding to a comment that academic research was not generally useful in acquisition practice, opined, “That's not their [the academics'] problem—it's ours [the practitioners']. They can only perform research; it's up to us to use it.” While we certainly agree with this sentiment, we also recognize that any research, however theoretical, must point to some termination in action; academics have a responsibility to make their work intelligible to practitioners. Thus we continue to seek projects that both comport with solid standards of scholarship, and address relevant acquisition issues. These years of experience have shown us the difficulty in attempting to balance these two objectives, but we are convinced that the attempt is absolutely essential if any real improvement is to be realized.

We gratefully acknowledge the ongoing support and leadership of our sponsors, whose foresight and vision have assured the continuing success of the Acquisition Research Program:

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- Defense Business Systems Acquisition Executive, Business Transformation Agency
- Office of Procurement and Assistance Management Headquarters, Department of Energy

We also thank the Naval Postgraduate School Foundation and acknowledge its generous contributions in support of this Symposium.

James B. Greene, Jr.
Rear Admiral, U.S. Navy (Ret.)

Keith F. Snider, PhD
Associate Professor



Panel 3 – Acquisition Issues: A Global Context

Wednesday, May 11, 2011	
11:15 a.m. – 12:45 p.m.	<p>Chair: Alfred G. Volkman, Director, International Cooperation, Office of the Under Secretary of Defense for Acquisition, Technology, & Logistics</p> <p><i>The Impact of U.S. Export Control and Technology Transfer Regime on the Joint Strike Fighter (JSF) Project—A UK Perspective</i></p> <p>David Moore, Peter Ito, Stuart Young, Kevin Burgess, and Peter Antill, Cranfield University</p> <p><i>International Perspectives of the Impact of Export Control and Technology Transfer Regimes: The F/A-18 Case Study</i></p> <p>Raymond Franck, Ira Lewis, Bernard Udis, NPS</p> <p><i>NATO Agency Reform</i></p> <p>Eugene Warner, U.S. Mission to NATO</p>

Alfred G. Volkman—Director, International Cooperation for the Under Secretary of Defense (Acquisition, Technology, and Logistics). Mr. Volkman is responsible for establishing international Armaments cooperation policy, ensuring that policy is properly implemented, and engaging with U.S. allies and friends around the world to achieve closer cooperation.

Mr. Volkman has a long history in international cooperation beginning in the late 1970s when he negotiated the initial agreements with the United Kingdom that resulted in the cooperative development of the AV-8B Harrier Aircraft. In the early 1980s he served on the NATO Air Command and Control Systems team in Brussels, Belgium, where he was instrumental in shaping the international acquisition strategy for that program. Mr. Volkman has served in a variety of international staff positions for both the Department of the Navy and the Office of the Secretary of Defense.

Mr. Volkman has extensive acquisition experience. He began his civilian career as a contracting specialist and contracting officer with the Naval Air Systems Command and has served as both the Director of Contract Policy and Administration and the Director of Foreign Contracting in the Office of the Secretary of Defense.

Mr. Volkman has a Bachelor of Arts degree from Valparaiso University and a Master of Business Administration from George Washington University. He served as an officer in the United States Army from 1966 to 1969. His service included one year with the Military Assistance Command, Vietnam. He has received numerous awards and medals for distinguished performance throughout his military and civilian service.

Mr. Volkman is married and has three adult children.



International Perspectives of the Impact of Export Control and Technology Transfer Regimes: The F/A-18 Case Study

Raymond Franck—PhD, Senior Lecturer, Graduate School of Business & Public Policy, Naval Postgraduate School. Professor Franck retired from the Air Force in 2000 in the grade of Brigadier General after 33 years of commissioned service. He served in a number of operational tours as a bomber pilot; staff positions, including the Office of Secretary of Defense and Headquarters, Strategic Air Command; and as Professor and Head, Department of Economics and Geography at the US Air Force Academy. His institutional responsibilities at NPS have included the interim chairmanship of the newly formed Systems Engineering Department (July 2002 to September 2004), serving as Associate Dean for Academic Operations (December 2007 to present), teaching a variety of economics courses, and serving on a number of committees to revise curricula for both the Management and Systems Engineering disciplines. His research agenda focuses on defense acquisition practices and military innovation. [rfranck@nps.edu]

Ira Lewis—PhD, Associate Professor of Logistics, Graduate School of Business and Public Policy, Naval Postgraduate School, Monterey, CA. His interests include transportation, public policy, and the international defense industry. [ialewis@nps.edu]

Bernard Udis—PhD, Professor Emeritus of Economics, University of Colorado at Boulder, and Visiting Research Professor, U.S. Naval Postgraduate School. Professor Udis has also served as Distinguished Visiting Professor of Economics at the U.S. Air Force Academy and as a William C. Foster Fellow at the U.S. Arms Control & Disarmament Agency. His NATO Research Fellowship examined the costs and benefits of offsets in defense trade. Professor Udis' published work includes three books: *The Economic Consequences of Reduced Military Spending* (editor, 1973), *From Guns to Butter: Technology Organizations and Reduced Military Spending in Western Europe* (1978), and *The Challenge to European Industrial Policy: Impacts of Redirected Military Spending* (1987). In addition, he has published numerous articles in scholarly journals on defense industries and military power. These include "Offsets as Industrial Policy: Lessons From Aerospace" (with Keith Maskus, 1992), and "New Challenges to Arms Export Control: Whither Wassenaar?" (with Ron Smith, 2001). A number of his works are considered classics in defense economics and have been reprinted in collections such as *The Economics of Defence* (2001) and *Arms Trade, Security and Conflict* (2003). Professor Udis' current research focuses on competition and cooperation in the aerospace industries of the US and the EU. [Bernard.Udis@colorado.edu]

Abstract

This report-in-progress is part of a joint project on export control and technology which involves collaboration efforts between teams of researchers at the Naval Postgraduate School and the Defence Academy of the United Kingdom, Cranfield University. As the U.S. group, we are reporting on our case study of the F/A-18 Hornet—with a view to gleaning insights into contemporary issues pertaining to export control and technology transfer regimes.

Introduction

This report-in-progress is part of a joint project on export control and technology which involves collaboration efforts between teams of researchers at the Naval Postgraduate School and the Defence Academy of the United Kingdom, Cranfield University. For purposes of the Eight Annual Acquisition Research Symposium, we are making separate presentations of our preliminary results. (We will, however, publish our final results jointly in one report.)

The U.S. group (above) is reporting on its case study of the F/A-18 Hornet—with a view to gleaning insights into contemporary issues pertaining to export control and



technology transfer retimes. The discussion that follows is motivated by our assumption that past experience.

Background and History¹

The F/A-18 is a supersonic, all-weather multirole fighter designed for carrier operations against air and/or ground targets. The aircraft is operated by the U.S. Navy and Marine Corps principally from carriers, although foreign air services operate primarily from land bases. The prime contractor is Boeing (after its absorption of McDonnell Douglas), while Northrop Grumman serves as the primary subcontractor. Northrop's responsibilities include the center and aft fuselage sections of the aircraft, while Boeing is responsible for the rest—this includes final assembly. By work share, Northrop provides 40% and Boeing provides 60%. On the E/F (Super Hornet) version, Northrop's share increased slightly to 42%.

The F/A-18 emerged from the U.S. Navy's Naval Fighter-Attack, Experimental (VFAX) program that was charged with developing a multirole aircraft capable of replacing the A-4 Skyhawk, the A-7 Corsair II, and the remaining F-4 Phantom IIs, and to complement the F-14 Tomcat.²

The Navy was ordered by Congress in August 1973 to seek a cheaper alternative to the F-14. Grumman and McDonnell Douglas each proposed somewhat less expensive variants of the F-14 and F-15, but their costs were still viewed as too high. Defense Secretary James Schlesinger then directed the Navy to assess the two competitors for the Air Force's Lightweight Fighter program, the General Dynamics YF-16 and the Northrop YF-17. However, that program was focused on a day fighter without strike capacity, and thus failed to meet the Navy's needs. However, some in Congress saw the possibility of new technologies developed for the LWF program making a useful contribution to the Navy's needs, and in May 1974, the House Armed Services Committee transferred \$34 million from the VFAX program to a new effort, the Navy Air Combat Fighter (NACF) program.

Although the YF-16 won the Air Force LWF competition, its single engine and narrow landing gear added to the Navy's conviction that it was not suitable for carrier service. The YF-17, however, offered two engines and was seen as possibly of interest for naval needs. Subsequently, the Navy received permission to pursue such possibilities, and it asked McDonnell Douglas and Northrop to design a new aircraft using the configuration and design principles which had been utilized on the YF-17. Northrop had recruited McDonnell as a secondary contractor to benefit from its long experience in building carrier aircraft.

What emerged from the partnership was the F-18, and while it differed significantly from the YF-17, its family connection should be recognized. On the F-18, the two companies originally planned to evenly divide the parts production, with McDonnell building the wings, stabilators, and forward fuselage, as well as being responsible for the final

¹ Sources for basic information on this aircraft include "McDonnell Douglas F/A-18" (n.d.), "VFAX" (n.d.), and Abaloufia (2010).

² In fact, the VFAX term applies to two specifications for two different naval fighter projects. The first sought a light, low cost complement for the F-111B capable of replacing the F-4 Phantom II for air control, escort, and air-to-ground missions in the early 1960s. This specification became obsolete when the F-14 Tomcat was selected as the VFX (Navy Fighter Experimental) winner, but it soon became clear that this aircraft was too expensive to replace the variety of missions performed by all Navy fighter and attack models. The second VFAX saw the Navy "invited" by the Secretary of Defense to examine the entrants to the Air Force's Lightweight Fighter Program. As noted, the Navy selected the loser of the Air Force competition, the YF-17.

assembly; while Northrop was to build the center and aft fuselage and vertical stabilizers. Northrop saw a possible export market for a land-based version (the F-18L) and assumed prime contractor responsibility and final assembly of that version, while McDonnell acted as prime contractor for the naval version.³

McDonnell undertook substantial modifications of the YF-17 to prepare it for carrier operations. They enlarged and modified the structure of the aircraft and added to its range. A most important modification was to replace the computer-assisted control system of the YF-17 with a digital fly-by-wire system with quadruple-redundancy, the first to be introduced into a production fighter aircraft.⁴

The original plan called for the production of three versions—a single seat fighter, a single seat attack plane, and a dual seat trainer which contained full mission capability except for a reduced fuel load. Improvements in stores stations and more advanced avionics and multifunction displays enabled the separate fighter and attack versions to be combined into a single aircraft. This was recognized in 1980, and its name was formally changed in April 1984 to the F/A-18A. The two seat model became known as the F/A-18B.

The F/A-18A had its first flight in November 1978, and its first Navy flight in March 1979. It entered operational service in Marine and Navy squadrons in January 1983 and March 1983. Its first combat operations took place in April 1986 during Operation Prairie Fire against Libyan air defenses. Funding for the C/D models began in the FY1986 budget. The new model saw a number of improvements introduced. It was equipped to carry up to six AMRAAM (Aim-120) missiles and up to four IR Maverick (AGM-65) missiles. In addition, provision was made for integration of the AN/ALQ-165 ASP (Advanced Self-Protection Jammer) system and reconnaissance equipment. Stores management was improved with upgraded computer hardware and memory capacity. An improved mission computer and new Flight Incident Recorder and Monitoring Set (FIRAMS) have also been installed. Models produced after 1993 were equipped with APG-73 radar, more capable than the APG-65 original equipment.

Despite these improvements, in 1987, the DoD commissioned McDonnell Douglas to study further possible upgrade packages, with the project name Hornet 2000. Four configurations were produced, aimed at addressing the frequent criticisms leveled at the F/A-18s: limited range and weapons load. Although Hornet 2000 was dropped, its studies provided useful approaches for the redesign of the A-D models into the E/F, or Super Hornet.

The arrival of development funds for the E/F versions was accompanied by reductions in appropriated funds for the earlier C/D models. This became marked in FY1995, and the DoD requested no funding for C/D models in FY1997. U.S. procurement of C/D models ended in FY1998 at a total figure of 635 aircraft.

³ Northrop's hopes for a significant export market for the F-18L were not realized. The F-16 became highly successful on export markets, and Northrop's relations with McDonnell deteriorated over what Northrop saw as a violation of the original plans to avoid direct competition abroad between the F/A-18 and F-18L. Northrop sued McDonnell in late 1979 for the unauthorized use of Northrop technology for foreign sales of the F/A-18. The case was settled in 1985 when McDonnell paid Northrop \$50 million for full rights to the design with no admission of wrongdoing. The significance of the settlement was limited, as by then, Northrop had ended work on the F-18L.

⁴ Another significant improvement resulted from having the issue of maintenance incorporated into the design, which resulted in the F/A-18 requiring much less downtime than such heavier predecessors as the F-14 Tomcat and the A-6 Intruder. Its mean elapsed time between failures is three times greater than other strike aircraft, and it requires half the maintenance time. The same design principles were utilized in the development of its General Electric F404 engines, which are less susceptible to stall and flameout than other comparable-sized engines.

Although the E/F version continues the basic name and design concept of the original F/A-18, it was significantly redesigned. While originally maintaining 90% avionics and software commonality with the F/A-18C/D model, its airframe is 25% larger, and features radar, avionics, and weapons upgrades and more powerful engines. Its weapons and fuel stores capacity have been significantly increased, and it can be utilized as an aerial refueling tanker. The newer models also provide frontal stealth qualities.

The enhanced capabilities of the F/A-18E/F are a possible explanation the Navy's decision not to seek to develop a direct replacement for the F-14 Tomcat. The multiple mission suites of the Hornet and Super Hornet may have allowed the retirement of a sizeable number of specialized Navy aircraft⁵ which had been fulfilling its combat aircraft roles with an associated reduction in logistics complexity.

The first production model of the Super Hornet was delivered to the Navy in December 1998. It is built by a team consisting of Boeing, Northrop Grumman, GE Aircraft Engines, Raytheon, and more than 1800 suppliers (domestic and foreign).

Export Sales of the F/A-18

The F/A-18 represents the largest multinational cooperative program in which the U.S. Navy has ever been involved. To date, seven foreign countries have purchased variants of this aircraft, principally the A-D models, while Australia has chosen to acquire the E/F model. The others in the user community are Canada, Finland, Spain, Switzerland, Kuwait, and Malaysia. With the exception of Canada, all the others have chosen to use the Foreign Military Sales (FMS) route. Since the U.S. Navy is the military service employing this aircraft, following the rules of that system, it is the intermediary which acts as purchasing agent for the foreign buyers in dealing with the manufacturers of that product. It should be noted that, unlike the F-35 Joint Strike Fighter case, these countries are buying an already existing aircraft currently in use by the U.S. Navy. Hence, while slight modifications are possible, their role essentially is that of customer rather than partner.

Such matters as the location of the assembly facility and the identity of the organization performing that function, as well as subsequent maintenance and modification, unless specified in the respective MOUs, are issues for determination between the customer and the principal contractors. This takes the U.S. government outside of the loop dealing with industrial participation in the buyer country.

Throughout the entire post-World War II period, countries buying foreign aircraft and other advanced technology products have attempted to acquire the underlying technologies in order to lessen their dependence on foreign sources. Frequently, this goal also reflected a belief that advanced technologies were the key to modern economic growth and a higher standard of living. These demands for industrial participation often were a major factor in selecting the winner of contract competitions.⁶ Not infrequently, they led to conflict with the supplier state over a perceived need to protect what were viewed as technologies crucial to national security. In the F/A-18 case, these conflicting goals were played out in the context of U.S. export control and technology transfer regulations.

⁵ Aboulafia (2010) identifies such retired aircraft as the F-14, A-6, S-3, KA-6, and EA-6. While recognizing the associated loss of specialization, he concludes that "the Super Hornet does these jobs very well" (Aboulafia, 2010, p. 16).

⁶ For a discussion of these issues, see Udis (2009).

Most of the remainder of this report will focus on the export control issue, but first, we will examine some production figures which have a bearing on the topic.

A recent NAVAIR report identified total deliveries of F/A-18 aircraft between 1980 and 2000 at 1480, which includes exports in excess of 400 (Powell & Renko, 2010). The dates of the announcements of purchase decisions ranged from 1981 (Australia) to 1993 (Malaysia). With the exception of Kuwait and Malaysia, all of the export buyers participated in the assembly of their aircraft. The same group (Australia, Canada, Spain, Switzerland, and Finland) all participated to varying degrees in the mid-life upgrades that all had ordered. Without exception, every member of this group claimed industrial benefits and technological advances from their experiences with the aircraft.⁷ This was matched with a high level of satisfaction with the performance of their aircraft and their working experience with U.S. Navy and industry personnel.

This should not be interpreted to mean that the projects were trouble-free, particularly with respect to the application of U.S. export control and technology transfer regulations. As noted above, this aircraft was an already existing and in-service weapons system in the U.S. Navy, and no sophisticated buyer would have expected to have carte blanche access to its complete technology suite. Unlike the F-35 Joint Strike Fighter case, they did not enter as dues-paying partners, participating in the design creation, almost from the very start. Most of the complaints dealt with more mundane issues like the transfer of spare parts, and test and repair capabilities between countries that had already been certified as members of the F-18 user community.

Securing of a blanket retransfer agreement in 2001 from the State Department would have helped to resolve such problems. Ostensibly, it covered the retransfer of “common and unclassified items and tech data of the F/A-18 weapon system between the international users; [freed such users from any] requirement to apply for advance USG consent for items on the ‘Master List’; [and delegated to PMA265] authority to amend/mod the ‘Master List’ by Department of State (DoS).” Over time, it became clear that authority was necessary to allow users to coordinate joint development efforts.

An MOU was obtained in 2005 to address this issue. It allowed “multinational exchange of information and initiation, conduct and management of cooperative efforts, [and also permitted] cooperation in acquisition arrangements and research, development, testing, evaluation, and production (including follow-on support) efforts” (Powell & Renko, 2010). Such definitions represent legal interpretations made within the State Department, but a change in personnel in the relevant office may lead to a change in interpretation. This seems to be an inherent tendency in bureaucratic organizations, but it can lead to significant problems for those outside the bureaucracy charged with making operational decisions, whose results depend upon the interpretations made within the bureaucracy.

Under current ITAR (International Traffic in Armaments) regulations, the export of components and spare parts must be separately approved, even when they are to be used in support of previously approved and exported end products.

It is of interest to note that after a long and rather unsuccessful history of attempts to reform the Cold War vintage collection of U.S. arms transfer regulations, a fresh attempt shows promise of adoption. In April 2010, Defense Secretary Robert Gates announced a new Administration plan for sweeping reforms aimed at the establishment of a single control

⁷ This and related information was obtained in a series of confidential interviews held with representatives of these five countries in June 2010 and February 2011.

list, administered by a single agency for licensing and enforcement, using a single information technology.

The plan was the product of a widespread interagency review of the current system directed by the President in the summer of 2009. In an August 2009 statement, he commented that "we need fundamental reform in all four areas of our current system in what we control, how we control it, how we enforce those controls, and how we manage our controls" (Office of the Press Secretary, 2010).⁸ If successfully implemented, which will require both executive and congressional action, many of the problems resulting from the implementation of current regulations may be significantly alleviated.

Concluding Comments

While the above examples represent problems which have been encountered through the life of the F/A-18 export sales, a new and widespread concern has appeared as the U.S. Navy approaches the end of its production run for that aircraft, and as its planned acquisition of the F-35C looms. Many of the foreign users of the F/A-18 intend to continue their use of that aircraft after the U.S. Navy expects to retire its use of the plane. The closure of U.S. production lines has introduced a serious concern about continued access to U.S. supplied parts and other essential components for foreign inventories. The NAVAIR International Programs group has undertaken a major effort to alleviate that potential problem through careful advanced planning.

This effort has been described in its document entitled *Sundown/Sunrise Plan*, authored by Randy Powell, Level 1 Director of the F/A-18 International Business IPT, dated December 9, 2010. This effort was widely praised by foreign representatives with whom we met.

A final note which may have some bearing on this effort is found in the renewed interest in the F/A-18 aircraft which has accompanied the widely publicized delays in the F-35 Joint Strike Fighter program (e.g., Warwick, 2011; Hennigan, 2011). Secretary of Defense Gates announced in January that the U.S. Navy would buy 41 additional F/A-18s to help close the gap caused by the delays in F-35 deliveries (Hennigan, 2011).

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⁸ Additional information may be found in Censer (2011) and Gillis (2011).



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Impact of Export Control and Technology Transfer Regimes: International Perspective

Raymond Franck, Ira Lewis, and Bernard Udis

Naval Postgraduate School

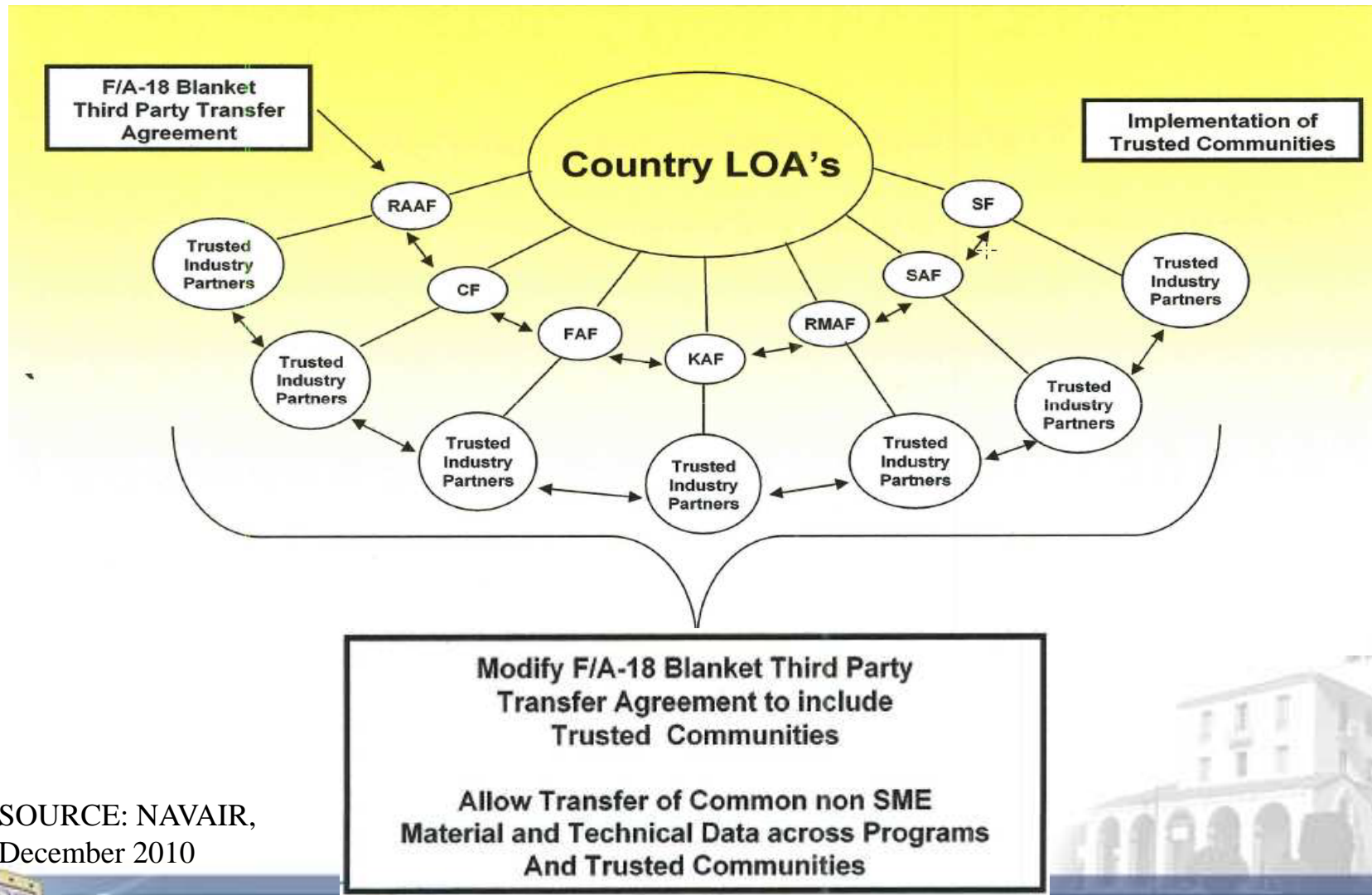
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OUTLINE

- INTRODUCTION (Chip Franck)
 - PART OF JOINT WORK IN PROGRESS
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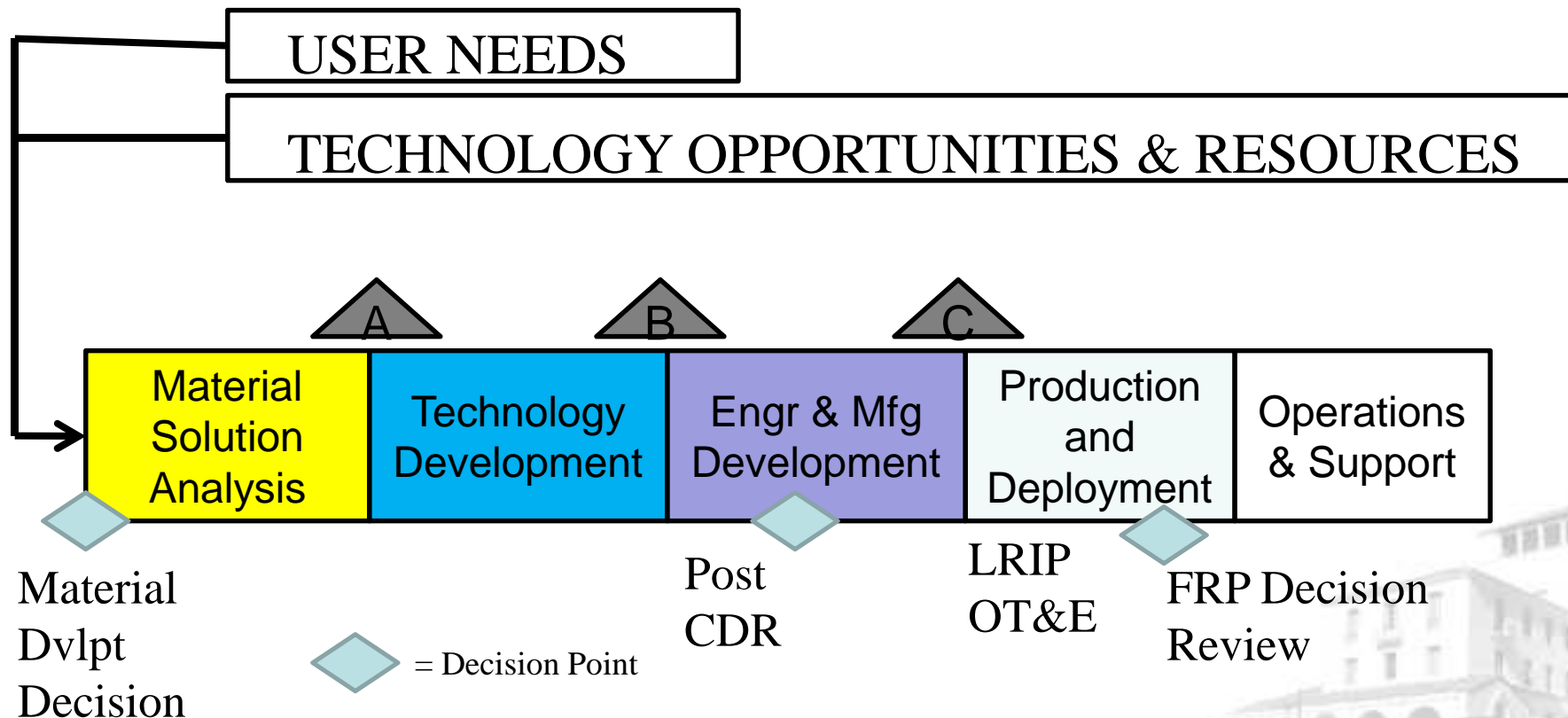
F-18 FMS PROCESS



SOURCE: NAVAIR,
December 2010



LIFECYCLE FRAMEWORK VIEW



SOURCE: Defense Acquisition Guidebook

